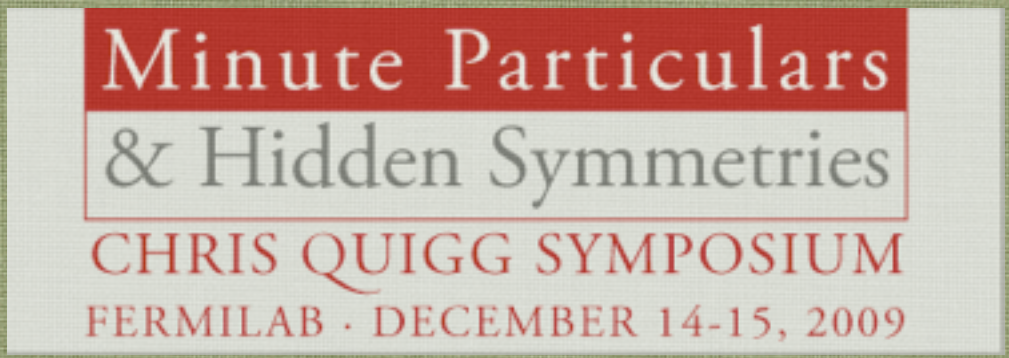
A Playful Approach to Physics:
The Serious Business of Educational Outreach

Elizabeth H. Simmons
Dean, Lyman Briggs College
Professor, Dept. of Physics and Astronomy
Michigan State University



What is Educational Outreach ?

What is Educational Outreach ?

Encouraging non-experts
to engage intellectually with
your favorite topic

Often Linked to Inclusion

ICWIP 2008

APS Women in Physics Speaker's Program

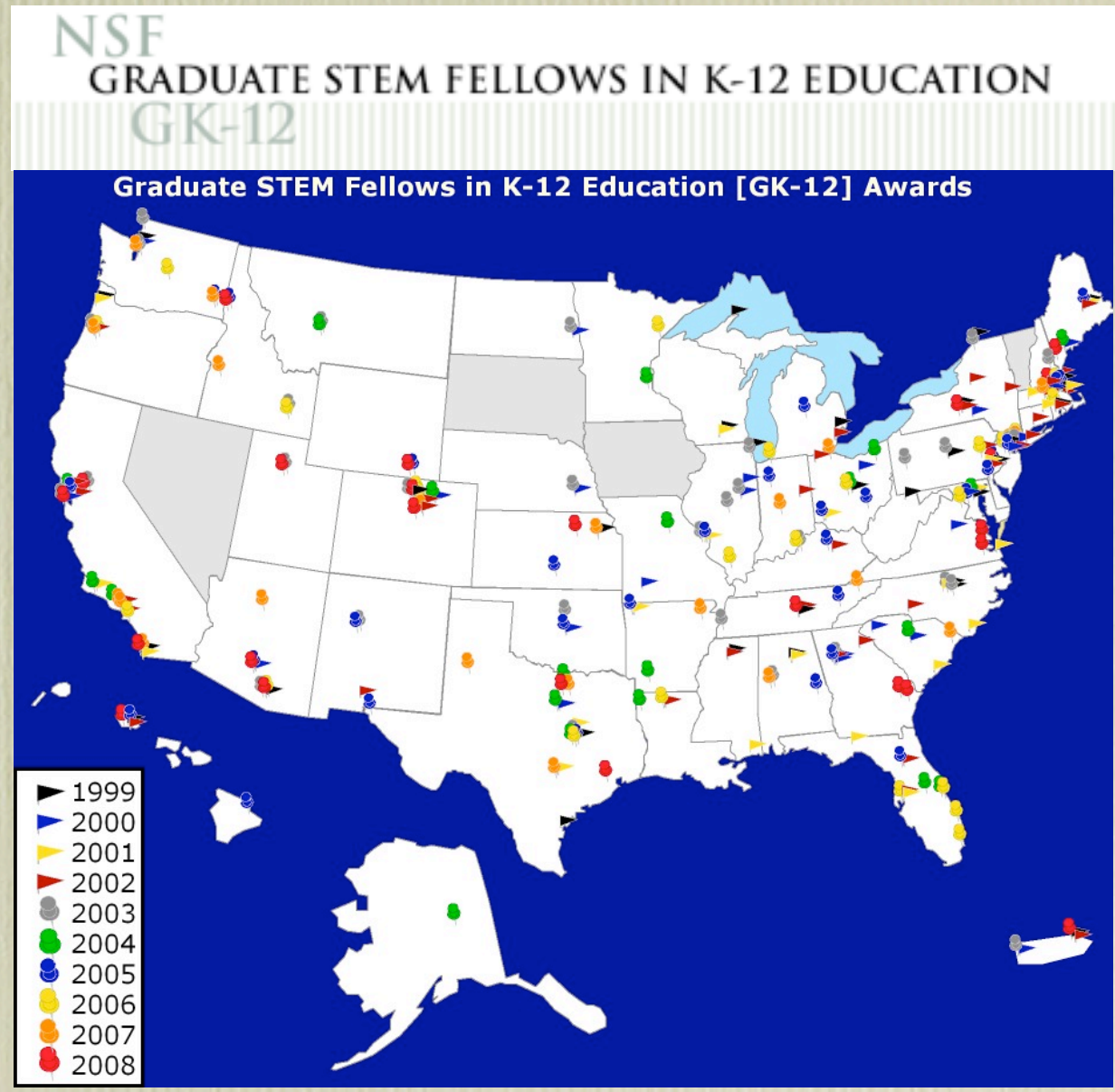
Colloquia on Women in Physics
[e.g., *The Leaky Pipeline: Causes and Solutions*, 12-2009 Nagoya University]

NO RIGID BOUNDARIES

Many National Science Foundation programs seek to involve new individuals in research:

GRFP
REU
RET
GK-12

Which are ‘outreach’?

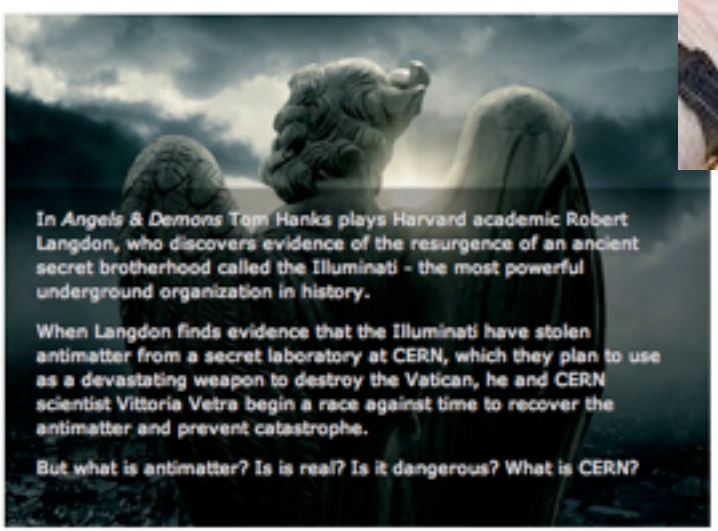


Frequently Playful

Organization for Nuclear Research

ANGELS&DEMONS

the science behind the story



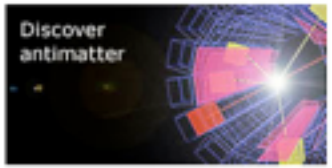
In *Angels & Demons* Tom Hanks plays Harvard academic Robert Langdon, who discovers evidence of the resurgence of an ancient secret brotherhood called the Illuminati - the most powerful underground organization in history.

When Langdon finds evidence that the Illuminati have stolen antimatter from a secret laboratory at CERN, which they plan to use as a devastating weapon to destroy the Vatican, he and CERN scientist Vittoria Vetra begin a race against time to recover the antimatter and prevent catastrophe.

But what is antimatter? Is is real? Is it dangerous? What is CERN?

Learn about CERN

CERN



Cui bono?

Well-designed outreach benefits
all who participate,
the ‘leaders’ as well as the ‘students’.


Professional Development
KICP
Kavli Institute for Cosmological Physics
AT THE UNIVERSITY OF CHICAGO
MSU High Energy Theory
SPACE CAMP
SSP
QuarkNet
BRIGGS MULTIRACIAL ALLIANCE
Service Learning
Research Immersion

The QuarkNet Collaboration

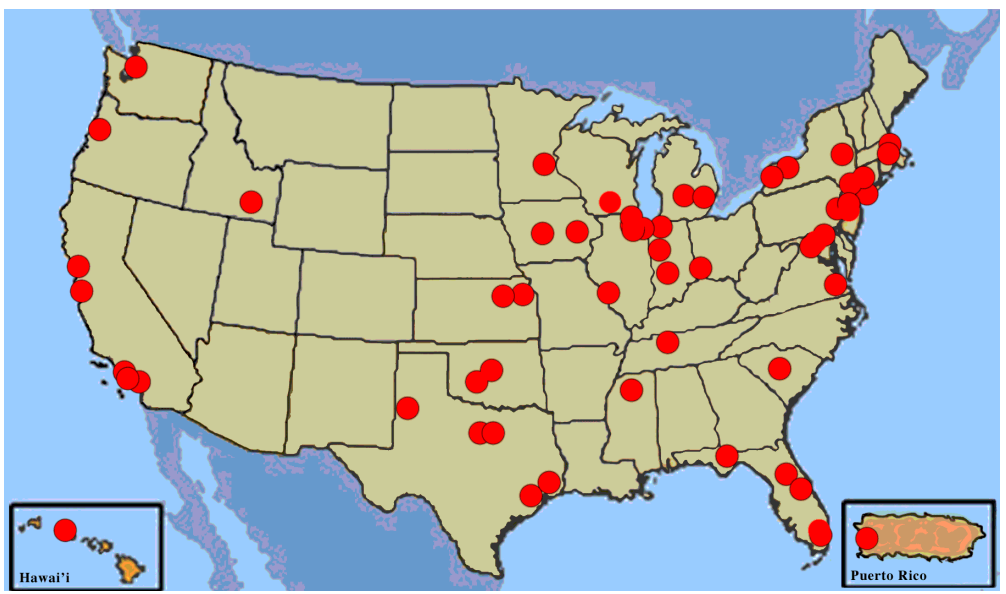
Outreach as Research Immersion

Involve students and teachers in ongoing physics research

QuarkNet

The QuarkNet Collaboration

After 10 years: in 25 states & Puerto Rico



50 centers work with 500+ teachers/schools and 100,000 students!
Associated with 11 experiments conducted at 7 DOE labs & CERN

quarknet.fnal.gov

Use of Cosmic Ray eLab to Teach the Research Process

Deborah Roudebush

Oakton High School

2900 Sutton Road
Vienna, VA 22181

AAPT 2009 Winter Meeting
February 15, 2009
Chicago, Illinois

Muon Detectors in High Schools

Cosmic Ray e-Lab

Logged in as group: CosmicCougars

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Join a national collaboration of high school students to study cosmic rays.

Why cosmic rays?

Spending all your time in a shower?

When you're sleeping or sitting in class, cosmic rays shower the earth and everything on it.

What are cosmic rays?

Where do they come from?

Where do they hit?

Some cosmic rays have so much energy that scientists are not sure where they come from. A number of reseach projects are looking at this question.

Who are we?

We're a collaboration of high school students and teachers collecting and analyzing cosmic ray data to answer some of these questions. We're working with computer scientists to provide cutting edge tools that use **grid techniques** to help you share data, graphs, and posters and collaborate with other students nationwide.

Logout

If you are not **CosmicCougars**,

Logout

Some were Experimentalists…

- Muon detector construction underway at Oakton High School:

…and Some Were Theorists

- Tutorial in data mining using muon data stored in eLab:

Science Fair Projects

- Christina and Richa are studying flux as a function of altitude and ground temperature :

•Scott is in charge of calibration and "Blessing Data":

•Rachel is studying Flux vs Time of Day

Office of Science
U.S. DEPARTMENT OF ENERGY

QuarkNet

NSF

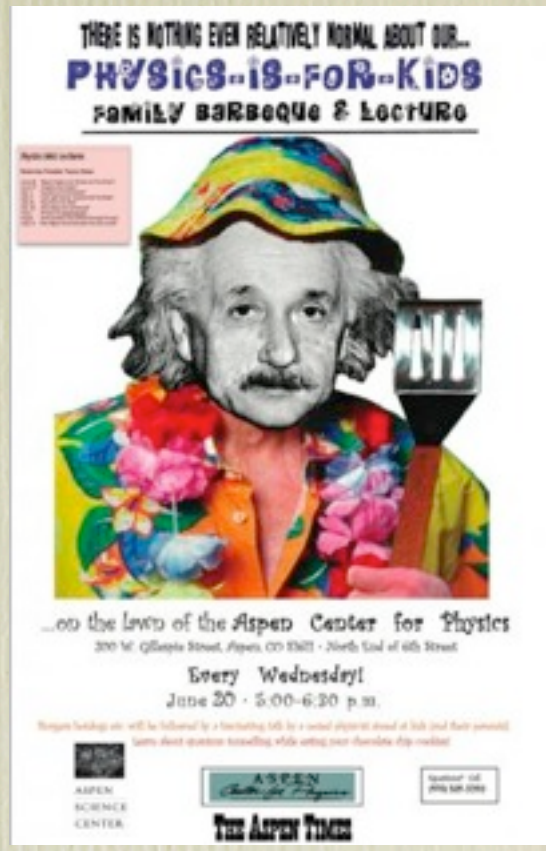
MSU High Energy Theory

Outreach as Professional Development

Faculty-student Outreach Collaboration

MSU physics professors:
E.H. Simmons and R.S. Chivukula

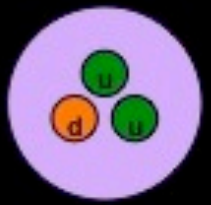
MSU Undergraduate Students:
Garrett Warnell 2005-06 Edita Klimyte 2006-07
Tyler Augst and Victoria Moeller 2007-08
Jamie Overbeek and Royce Grewer 2008-09



GRANDPARENTS UNIVERSITY

The Building Blocks of Matter

Protons



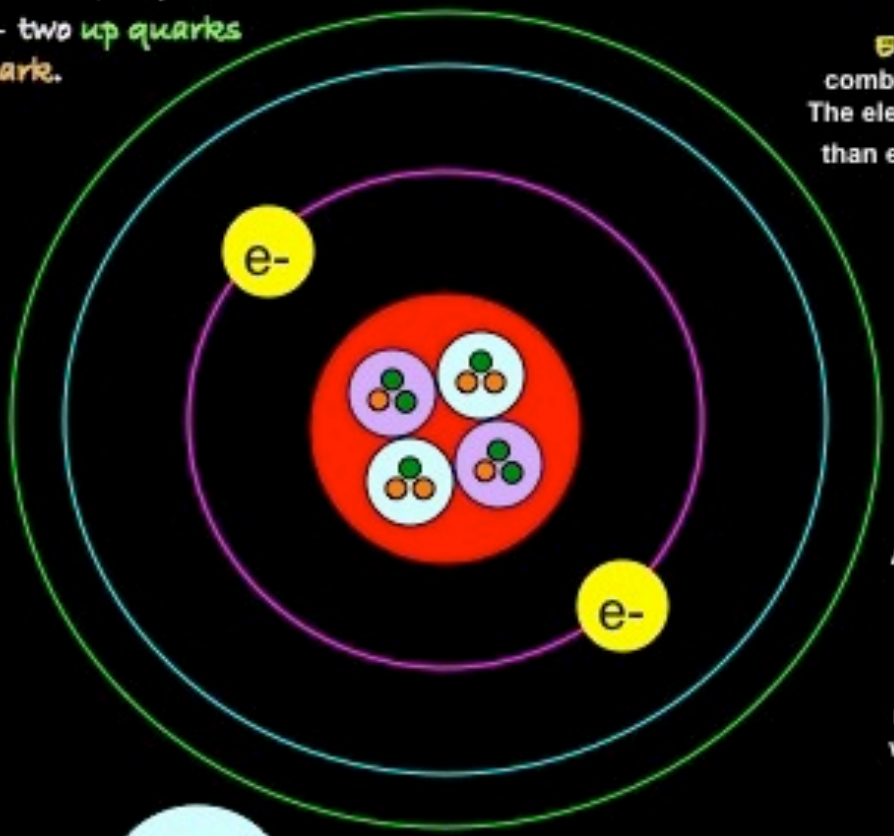
The proton is a particle that appears in the nucleus of atoms and has a charge of +1. However, the proton itself is composed of three quarks – two up quarks and one down quark.

Electrons

Electron, like quarks, are not combinations of any smaller particles. The electron has considerably less mass than even a quark, and has an overall charge of -1.

Quarks

One of the basic particles of matter, a quark always combines with other quarks to form larger structures. Protons and neutrons are made out of up and down quarks. The up quark has a charge of +2/3 and the down quark has a charge of -1/3.



*This Helium atom is not to scale.

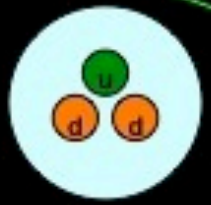
The Atom

All of the particles to the left come together to form an atom. This one contains two neutrons, two protons, and two electrons.

Notice the number of protons is equal to the number of electrons. This is so their charges will cancel (-2 +2 = 0), and as a result the atom itself will have no charge.

Large collections of atoms make up the substances you see every day. For example, the atom shown is Helium, the gas inside floating balloons.

Neutrons



The neutron is very similar to the proton in that it is also composed of three quarks. However, the neutron contains two down quarks and only one up quark. This accounts for the difference in charge between the neutron and the proton – the neutron has no charge.

http://www.pa.msu.edu
http://www.msu.edu
http://www.lymanbriggs.msu.edu

Equipment Sheet: Atom Building

Gold & Silver wrapped Hershey Kisses [up and down quarks]

Small plastic containers (or clear plastic bags)

Place 2 gold (up quarks) and 1 silver (down quark) Kisses in a container to form a proton; vice versa to form a neutron.

The strong nuclear force (lid) seals the quarks into the proton.

Ping-pong ball [electron]

Elastic cord [electric force]

Cut a small slit in the ping-pong ball; knot one end of the cord and insert in the slit.

Larger plastic container (or clear plastic bag)

Place multiple nucleons inside the container to form a nucleus; attach the far end of the electron's cord to the nucleus. The example shown here is Helium.

UV Beads

Setup Time: 5 min.

Number of People Needed: 1

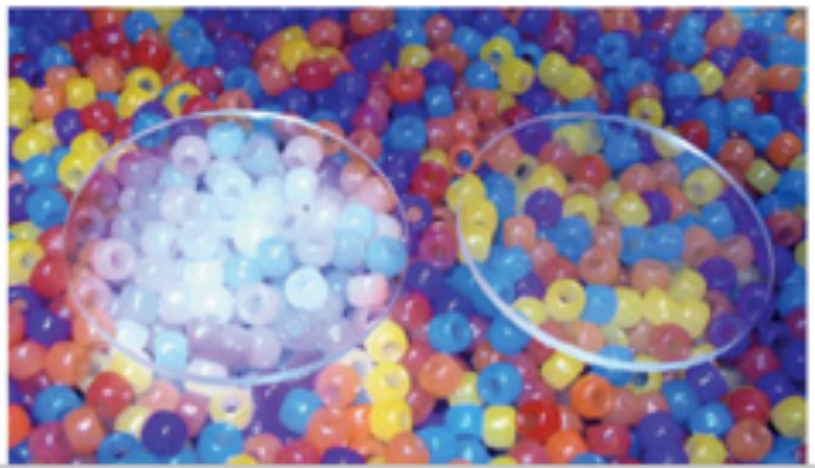
Demonstration Time: 15-20 min.

Number of Students: 10

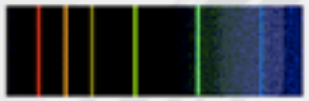
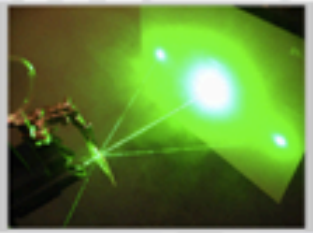
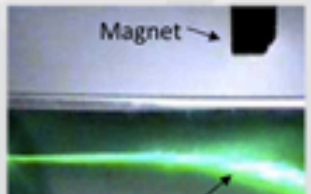
Materials: Pipe cleaners, UV sensitive beads, UV source, UV transparent and UV opaque disks

Purpose: Using UV beads and the different disks introduce the concept of UV light as one of the invisible frequencies of light. Also, to show how UV can go through some materials and not others.

Instructions: First show how the beads react to the UV light and explain what UV light is and where it can be found. Then using the opaque and transparent disks show how UV light can go through some materials and not others. Next have the kids take some beads and put them on the pipe cleaners to make bracelets, zipper pull, or a similar little project that they can take with them

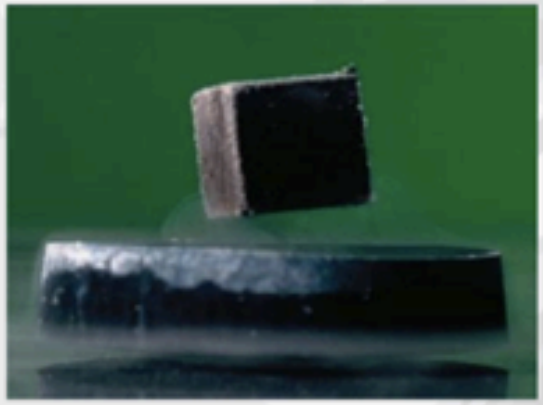
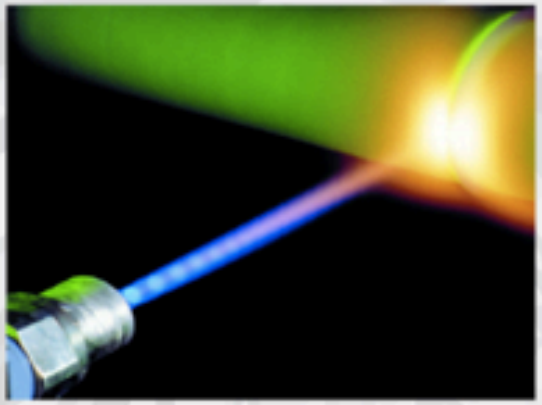


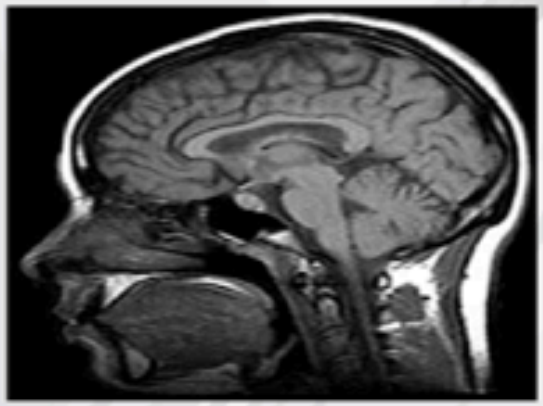
MSU High Energy Theory

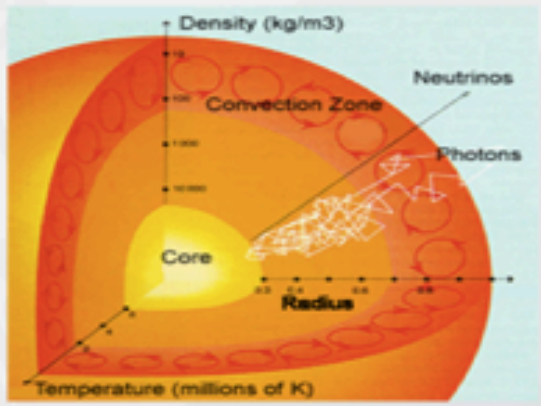
Title	Picture	Description	Documents
Atom Building		Use candy and other simple materials to create first protons and neutrons and then atoms to understand the building blocks of matter.	• Tip Sheet: (docx) (pdf) • Atom Model Slide: (pptx) (pdf) • Equipment: (pptx) (pdf)
Atomic Spectra		Using gas discharge tubes and diffraction gratings, introduce the electromagnet spectrum and atomic emission spectrum and demonstrate how spectroscopy can be used to identify an element or compound.	• Tip Sheet: (docx) (pdf) • Photon Emission Slide: (pptx) (pdf) • Discharge Spectra Slide: (pptx) (pdf) • Atomic Spectra Slide: (pptx) (pdf) • Equipment: (pptx) (pdf) • Student Worksheets: (docx) (pdf)
Diffraction		Demonstrate the wave properties of light by exploring how laser light behaves when traveling through small openings.	• Tip Sheet: (docx) (pdf) • Light Slide: (pptx) (pdf) • Atomic Spectra Slide: (pptx) (pdf) • Equipment: (pptx) (pdf)
Electrons		Using a cathode ray tube, show students a beam of electrons. Let them explore how that beam reacts to magnetic and	• Tip Sheet: (docx) (pdf) • Building Blocks Slide: (pptx) (pdf)

MSU High Energy Theory

Atoms at Work





Department of Physics and Astronomy
Biomedical Physical Sciences Building (map)
Michigan State University
East Lansing, MI 48824-2320
(517) 884-5581 (hep office)
(517) 355-6661 (hep fax)

Spartan Science Day

Outreach as Service Learning





LYMAN BRIGGS COLLEGE

1967 2007

Lyman Briggs is an undergraduate, residential learning community at MSU, devoted to studying the natural sciences and their impact on society. Its building houses laboratories, classrooms, and student residential, dining, and recreational facilities. With 1900 students, LBC offers the "best of both worlds": the benefits of a liberal arts college and the resources of a great research university.





Flint schools & teachers participating in Spartan Science Day

Brownell Elementary School
Ms. Catanja Harrison

Williams Elementary School
Ms. Karen LaLonde

50 miles apart

5th grade students visiting from Flint, waiting for the program to begin.

MSU's student-run Science Theatre performs demonstrations:

... including a Dance of the Sound Vibrations...

... Flint students get in on the act!

Making slime with Dr. LaDuca

Microscopes & Cells with Drs. Luckie, Smith & Urquhart

Perspective from Flint teachers

- Many of my students come from homes where no one has ever gotten past high school.
- When I talk to my students about college and career plans they say "My mom says poor kids can't go to college...." This trip helps counter what they're hearing at home.
- Many students didn't know what a college was before this day and had never set foot in one before... they left he program saying "I want to go there!"
- The MSU students were awesome with the kids, even with those who usually present behavior problems. There was a spirit of camaraderie.
- One of the best field trips EVER!

Perspective from Student Organizers

- The kids we were targeting are among the least privileged kids in the entire state - some coming from families that earn less than $8000 per year. Many of those kids have no idea what it means to go to college.... I am hopeful that as they grow up, they'll remember the fun they had at MSU and will see college as a realistic goal, not as an unrealistic dream.

- At the end of the day, just before the kids left, we asked how many of the kids would like to go to college someday. And when almost every single one of them raised their hand, that gave me all the satisfaction and reward that I needed for all the work that was put into it.

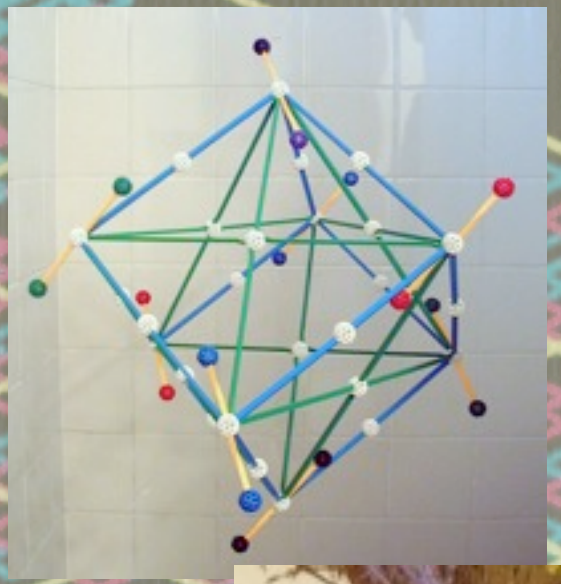
- Getting ten and eleven year old kids excited about science experiments, physics demonstrations and the use of technology could be paramount to their desire for education.

- I know I gained a greater sense of appreciation for my education, and those that have guided me along the way, i.e. my parents and teachers.

End of the Program

(Can you spot the physics handout?)

Thank you, Chris!



QUARKSUNBOUND